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ROCKS OF THE McCALLS FERRY QUADRANGLE, PENNA.

By Anna I. Jonas

Introduction.

The McCalls Ferry quadrangle lies between Lancaster and Peach Bottom. Susquehanna River, which crosses the quadrangle from the northwest to the southeast corner, divides it almost equally between York and Lancaster counties. The geologic mapping of the area was done in cooperation between the United States Geological Survey and the Topographic and Geological Survey of Pennsylvania and represents the joint work of Eleanora Bliss Knopf and Anna I. Jonas.

Drainage.

The quadrangle lies within the upland plateau region of southeastern Pennsylvania. The most conspicuous feature of the area is the Susquehanna River. It flows southeastward in a rocky gorge cut to a depth of several hundred feet below the surrounding upland surface. Since the days of the Indian the river has been used as a highway of travel. In the 19th century the York County Tidewater Canal was a busy artery of transportation but after the building of the Columbia and Port Deposit branch of the Pennsylvania Railroad on the Lancaster County side, the canal fell into disuse.

The Susquehanna is a turbulent river that flows for the most part in a rocky channel occupying about one-fourth of the width of the river's bed. The fall is 120 feet in 23 miles across this area, an average fall of 5.2 feet to the mile. Some of the water power of the river was harnassed in 1905 when the dam and hydroelectric plant was built at McCalls Ferry, 23 miles above tidewater. From this plant, which has 8 main generator units with a total capacity of 86,000 kilowatts, the Pennsylvania Water and Power Company supplies

electricity to the cities of Lancaster, Pennsylvania, and Baltimore, Maryland, and Edgewater Proving Grounds, Maryland.

The most important tributaries of the Susquehanna are Conestoga, Pequea and Muddy Creeks on the Lancaster County side, Fishing, Otter and Muddy Creeks on the York County side.

The Rocks.

The rocks of this area were deposited as sediments in bodies of water. Material derived from the wearing away of a land surface was carried by the rivers in suspension or solution and deposited in the sea either as gravel, sand, silt or lime mud. Later it was consolidated and hardened by pressure of the overlying beds and by heat from the interior of the earth. Had the processes of change stopped at this point the resultant rocks would have been arkose, sandstone, shale and limestone. But the rocks have undergone various alterations that resulted in the complete recrystallization of the original mineral constituents and the formation of textures that are different from those of the original sediments. Such recrystallized rocks are known as schists. A schist is a metamorphic rock possessing a foliated structure that causes it to split readily along planes approximately parallel. The rocks of this area are, for the most part, crystalline schists.

The oldest rocks in this region are the Wissahickon schist and the Peters Creek quartzite and schist. They belong to one of the oldest eras of geological history, the pre-Cambrian. The Wissahickon schist of this area is the northern phase of the Wissahickon mica-gneiss of the Philadelphia region. It is typically developed in the Tucquan anticline which crosses Susquehanna River at Tucquan. The Peters Creek formation was named by Eleanora Bliss Knopf and the writer because of typical exposures along Peters Creek, a tributary to the Susquehanna River near Peach Bottom Station, Lancaster County.

The Wissahickon schist is an albite-chlorite schist or gneiss interbedded with layers of chlorite-or muscovite-quartz schist. Other minerals usually present are calcite, epidote, garnet and magnetite.

The Peters Creek formation consists of a quartzite and a chloritic or sericitic schist. The quartzite is a white to light greenish gray, crystalline rock with some feldspar and muscovite. The schist is made up of bands of granular quartz between layers of sericite and clinochlore. Magnetite is usually present.

These schists are several thousand feet thick and are widely exposed over the south half and much of the north half of the McCalls Ferry quadrangle.

In the northern part of the area are rocks which belong to younger geological periods, the Cambrian and Ordovician. The Cambrian rocks were deposited on an old, smoothed-off, erosional surface of pre-Cambrian rocks. The oldest Cambrian rock exposed in this area is

the Harpers albite schist. It is a light to dark gray fine-grained rock composed of biotite, muscovite, quartz, albite and some calcite. Tourmaline needles are of frequent occurrence. Towards its top the Harpers schist becomes more quartzose and calcareous and passes into the Antietam albite schist, the metamorphosed representative of Antietam sandstone. The Antietam calcareous schist grades upward into the gray Vintage dolomite. This dolomite or magnesian limestone is the basal member of the lower Cambrian limestone series widely exposed north of the McCalls Ferry quadrangle. The dolomite is granular, massive, blue to gray, and weathers chalky white. Some beds are thinner and contain calcareous blebs that weather in relief.

Crystalline limestone (marble) and black slate and limestone conglomerate overlie the Vintage dolomite. The limestone is blue and sparkling, with finer grained dense dark blue beds usually gashed with white calcite veins. The black slate forms partings and thicker beds in the marble series. In some places mica has been developed on the partings. Pyrite is commonly present in crystals, sometimes in veins. This blue limestone series is Ordovician and much younger geologically than the Vintage dolomite beneath it.

The rocks so far described originated as sediments. Rocks known as igneous because they were once in a molten condition also occur in the area. The molten material came up from lower down in the earth and filled fissures in the rocks. These fissure fillings are called dikes. In York County, near Peach Bottom, there is a small exposure of a dike rock called serpentine or soapstone. It is a crystalline schist which has been developed from an original magnesian silicate rock of igneous origin. The rock is light green to cream colored, soft with soapy feel and made up largely of the mineral steatite. Naturally the serpentine dike, which represents the injection of molten material into a fissure, is younger than the Peters Creek schist into which it is intruded.

A more prominent and extensive dike cuts the rocks of this area for 18 miles in a southwesterly direction from the northern edge of the quadrangle through Rockhill on Conestoga Creek, through Pleasant Grove and Muddy Creek Forks. The rock of this dike is diabase, popularly known as trap. It weathers into round yellow-coated bowlders that strew the surface along the course of the dike. Diabase is a grayish black crystalline rock composed of sparkling small laths of feldspar and black augite. It is the only rock of the region that has not been altered since it hardened, and is the youngest rock of the area for it cuts all the others. It is an offshoot of the great outpouring of Triassic lava that forms the Palisades of New York and New Jersey and crops out in many places in eastern Pennsylvania.

Structure.

When the rocks of this area were laid down on the sea bottom as sediments they were in nearly horizontal beds, one layer above another. They were buried to a great depth by other sediments and while so buried were compressed vertically by weight of rock cover, and were subjected also to a lateral pressure acting on them from the southeast,

the direction of the Atlantic Ocean. As a result of the pressure the rocks were thrown into a series of parallel arches and troughs, and lifted above sea level. Erosion acting upon the rocks has removed the covers of the arches and troughs, that we call anticlines and synclines, and has produced the irregular surface distribution of the rocks as we now see them. The linear direction in which the rocks trend is called the strike. In this area the rocks strike for the most part southwest. In the valley to the north the older rocks, the Harpers and Antietam schists, form hills that rise above the general level. The hills are anticlines and the intervening valleys of crystalline limestone are synclines. The Tucquan anticline with its axis at Tucquan is a large arch whose flanks are crumpled into smaller anticlines and synclines and these again are wrinkled until the smallest folds are of dimensions seen in the hand specimen. The Peters Creek syncline is south of the Tucquan anticline, and, like it, is composed of numerous minor folds.

Lateral pressure not only bends rocks into arches and troughs but may incline these folds to the point of overturning. The rocks may give way under the strain and break as well as bend. As the result of continued lateral pressure blocks of rocks or parts of the earth's crust may be pushed over other blocks or parts, for short distances or for many miles. Such a break is called a thrust fault and the plane along which the rocks move is called the thrust plane. A thrust fault of considerable extent occurs in this area. The pre-Cambrian Wissahickon schist has been pushed from the southeast over the Cambrian and Ordovician rocks of the limestone valley. The trace of the fault plane on the surface is the sinuous northern boundary of the Wissahickon formation. North of this line the rocks that composed the overthrust-block have been removed by erosion. As erosion continues more of the overlying schist block will be removed and a greater extent of valley rocks will be uncovered.

The McCalls Ferry quadrangle exhibits two areas fairly distinct topographically, a broad valley country between Washingtonboro and Willow Street, and a dissected upland in the rest of the quadrangle. Difference in solubility and hardness of the underlying rocks accounts for these features. The broad valley country is underlain by dolomite and crystalline limestone, rocks that are more readily soluble and not so hard as those in the rest of the quadrangle. The general level of the higher hills in this broad valley is about 400 feet above sea level. The sand hills that rise above the general level of the valley in Conestoga and Pequea townships are underlain by the harder Antietam and Harpers schists.

South of this limestone valley is a broad, well dissected upland. The hills in any part of this upland rise to a general level, but a study of the topographic map shows that if the valleys were filled the general surface would be a warped plain rising from an altitude of about 600 feet along the south side of the limestone valley to 800-900 feet along the Tucquan anticline, or from Brogueville to Rawlinsville, and thence sloping gently to the southeast. Near Peach Bottom the upland is 400-450 feet above sea or about the same as in the limestone valley at Willow Street.

This upland has been caused by the presence of the Wissahickon and Peters Creek schists that are hard, compact, and not readily soluble. The effect of erosion has been much slower on these schists than on the limestone, and the difference in elevation between the plateau and the valley is explained by the difference in resistance of the underlying rocks.

Susquehanna River flows southeastward across the trend of the rocks which is northeast and southwest. Streams that have long been flowing over certain formations are influenced in their courses by the relative position of yielding and resistant rocks. The accepted explanation for the lack of adjustment of Susquehanna River to the trend or strike of the rocks across which it flows is as follows: The river established its present course when the surface of this region was almost a plane that sloped gently to the southeast. This plane bevelled the rock structures and the river course was determined by its slope. Consequently it now flows directly across rock folds and overthrusts.

Difference in hardness of the rocks across which it flows has determined the width of the Susquehanna River bed. It is widest near Washingtonboro where the valley is cut in soluble limestone. Through the Wissahickon schist, the hardest and most resistant of the rocks, the channel is narrow, and the valley sides are steeper. The narrows below York Furnace and Tucquan have caused ice jams and high floods. The river widens again below Fites Eddy where it is cutting through the Peters Creek formation which is harder than limestone but not so resistant as the Wissahickon schist.

Economic Features.

Limestone. - The blue crystalline limestone belt in the northern part of the area contains valuable stone that might have a wide range of uses, as for building stone, ballast and road metal and for making lime and cement. Several quarries have been opened in the northern part of the quadrangle and the stone is used locally, but practical features restrict the development of the industry.

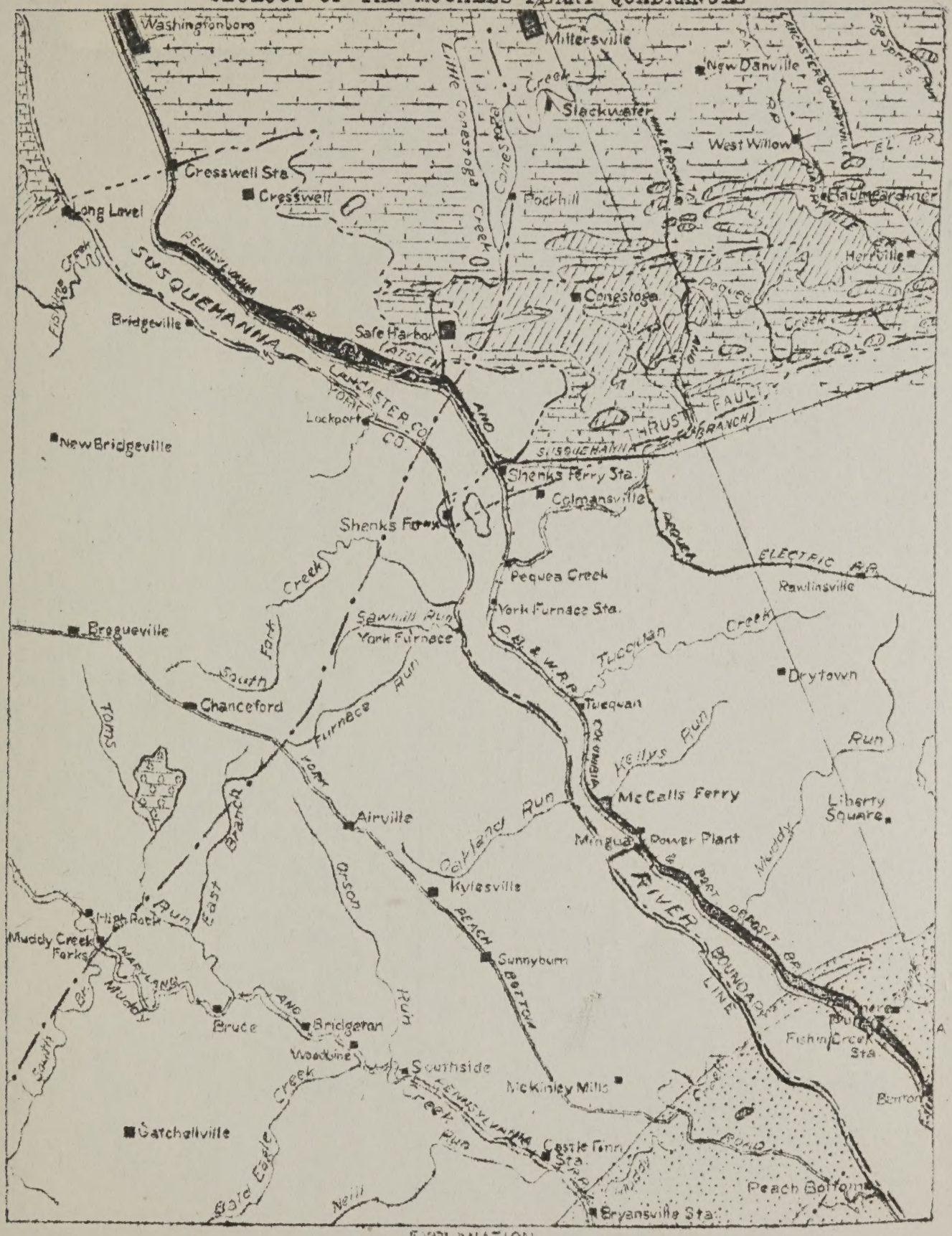
In former years much lime was burned locally for agricultural purposes. Old kilns still can be seen and are occasionally used in burning such lime as the neighborhood requires. At present the manufactured product can be bought so cheaply that burning of lime on the farm has declined.

Silver. - Along Silver Mine Run just north of Burnt Mills there is an old abandoned silver mine. Work was begun 125 years ago and a shaft sunk, connecting with a tunnel 400 feet into the hill. The ore, which is argentiferous galena, occurs in a quartz vein in marble. It is reported that lenses of ore the size of a barrel were found but they soon pinched out and no large ore body was discovered.

Iron. - There is considerable magnetite in the Cambrian schists west of Burnt Mills. In 1903 an unsuccessful attempt was made to mine this magnetite.

Limonite occurring in limestone has been mined at several places. The largest mines were the Grubb ore banks east of Shenks Ferry. They were operated from 1840 to 1885. The best ore was removed, and the remaining deposits are believed to be small. At least, present conditions do not warrant mining of the known deposits.

GEOLOGY OF THE McCALLS FERRY QUADRANGLE



EXPLANATION

LOWER CAMBRIAN SEDIMENTARY ROCKS

- Limestone (Not subdivided) In part Ordovician
- Antietam-Harpers Schist

PRE-CAMBRIAN UNCONFORMITY

- Quartzite & Chlorite Schist (Peters Creek)
- Albite Rock
- Wissahickon Schist
- Marble

IGNEOUS ROCKS

TRIASSIC
- Diabase

PRE-CAMBRIAN
- Serpentine & Soapstone

Fault

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